Optimal treatment planning for head and neck VMAT: evaluation of a tool to predict parotids sparing

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**Introduction**

Intensity-Modulated Radiation Therapy (IMRT) allows a hyper-personalization of treatment to the patient’s anatomy. The complexity of the clinical objectives yields a variability in treatment planning, especially between operators. A major difficulty is actually to appreciate the optimality of treatment plans. The aim of this study is to evaluate the benefits of a model which predicts the achievable mean dose to parotids during the treatment planning for head and neck (H&N) treatment.

**Materials and methods**

Treatment plans were calculated with Pinnacle v.9.10 (Philips) treatment planning system for Volumetric Modulated Arc Therapy (VMAT) techniques. A predictive model was defined according to the method proposed by Moore et al. [1], using the overlap volume between parotid and Planning Target Volume (PTV).

Twenty patients treated for H&N cancer with integrated boost technique were used to generate the model. These patients were divided into 3 groups: 10 patients with 3 levels of prescribed dose 70/63/56 Gy, 5 patients with 3 levels of prescribed dose 66/59.4/54.1 Gy (post-operative) and 5 patients with 2 levels of prescribed dose 60/54 Gy (post-operative). Then 10 treatment plans were calculated with and without the model: 8 patients with 3 levels of prescribed dose 70/63/56 Gy and 2 patients with 2 levels of prescribed dose 60/54 Gy. Dose distribution for both plans were normalized to obtain the same conformation of 95% isodose in PTV with high dose level. Each treatment plan was validated by physician. The evaluation was based on a comparison of doses to PTV, to parotids and to spinal cord PRV (spinal cord + 3 mm), indexes of conformity (CI) and homogeneity (HI) and the number of Monitor Units (MU).

**Results**

Table 1 shows the results treatment plans with and without the prediction model. On average, mean dose to parotids decreased of -5.3 Gy using the model. Conformity index and maximal dose to the spinal cord PRV were similar with the tow methods. However, plans obtained by using the prediction model show less homogeneity in the doses to PTV. Furthermore, these plans had generally more MU: +13% on average [-3.1%; +32.6%], which indicates an increased complexity in the generated plans.

**Conclusion**

This study showed the feasibility of using our own predictive model to reduce significantly the dose received by the parotids in case of H&N treatments, with potential clinical benefits.

The suggested model provides a target on mean dose to parotids at the beginning of treatment planning: integrating this method in the workflow of treatment planning should yield a time reduction and less inter-operator variability.

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|  |  | **Without model** | **With model** | **Target value** |
| **High dose PTV** | CI | **0.986\***[0.979 ; 0.998] | **0.986\***[0.979 ; 0.998] | 1 |
| HI | **0.060** [0.032 ; 0.100] | **0.077**[0.041 ; 0.111] | 0 |
| **Intermediate dose PTV** | CI | **0.971**[0.954 ; 0.987] | **0.969**[0.947 ; 0.986] | 1 |
| HI | **0.162**[0.096 ; 0.211] | **0.191**[0.137 ; 0.237] | 0 |
| **Low dose PTV\*\*** | CI | **0.992**[0.981 ; 0.997] | **0.991**[0.985 ; 0.997] | 1 |
| HI | **0.131**[0.098 ; 0.166] | **0.139**[0.107 ; 0.190] | 0 |
| **Homolateral parotid** | Dmean (Gy) | **26.20**[11.97 ; 38.64] | **20.21**[12.04 ; 25.91] | < 26 Gy |
| **Controlateral parotid** | Dmean (Gy) | **23.63**[8.95 ; 36.80] | **18.97**[11.56 ; 29.22] | < 26 Gy |
| **Spinal cord PRV** | D2% (Gy) | **37.57** [34.70 ; 39.64] | **38.25** [35.00 ; 40.98] | < 45 Gy |

***Table 1:*** *Treatment planning in head and neck VMAT with and without predictive model of mean dose to parotids*

*(mean for 10 patients or \*\*8 patients, [extremes]), \*plans normalization point*

**References**

[1] KL. Moore et al. – Experience-based quality control of clinical intensity-modulated radiotherapy planning – Int. J. Radiation Oncology Biol. Phys. Vol81 n2 – 2011

**Key words**

Treatment planning, Dose prediction, Head & Neck, VMAT, Quality control